Claims

What is claimed is:

1. A layer transfer structure comprising a carrier substrate having a porous region with a tuned porosity in combination with an implanted species defining a separation plane therein.

2. The structure of claim 1, wherein the separation plane is defined by a position and an amount of the implanted species.

3. The structure of claim 1, further comprising a transfer layer on the carrier substrate.

4. The structure of claim 1, further comprising a tunable thermally regrown epitaxial layer.

5. The structure of claim 4, wherein a component selected from the group consisting of a device layer, an interposer structure, a functional layer and combinations comprising at least one of the foregoing components is formed in the tunable thermally regrown epitaxial layer.

6. The structure of claim 1, wherein the porous region comprises a varied porosity.

7. The structure of claim 1, wherein the porous region comprises at least two different porosities.

8. The structure of claim 1, wherein the implanted species are selected from the group consisting of dopants, non-dopant ions and combinations comprising at least one of the foregoing species.

9. The structure of claim 1, wherein the implanted species comprise silicon ions.

10. The structure of claim 1, wherein the carrier substrate comprises silicon.

11. The structure of claim 3, wherein the transfer layer is formed by a process selected from the group consisting of spin on coating, plasma enhanced deposition, physical vapor deposition, chemical vapor deposition, patterning methods and combinations comprising at least one of the foregoing process.

12. A method of forming a layer transfer structure, the method comprising the steps of:

providing a carrier substrate; and

processing the carrier substrate to create a porous region with a tuned porosity in combination with an implanted species defining a separation plane therein.

13. The method of claim 12, wherein the separation plane is defined by a position and an amount of the implanted species.

14. The method of claim 12, wherein the processing step further comprises the step of anodizing areas of the porous region comprising the implanted species to create the separation plane.

15. The method of claim 12, wherein the processing step further comprises the steps of:

implanting a first species comprising boron; and

implanting a second different species.

16. The method of claim 12, wherein the porous region is thermally treated to form a regrown epitaxial layer.

17. The method of claim 12, wherein the porous region is implanted with a gas comprising hydrogen gas.

18. The method of 12, wherein the processing step further comprises the step of finally tuning the porosity of the porous region by anodization of the carrier substrate.

19. The method of claim 16, wherein the formation of the regrown epitaxial layer comprises tuning the thickness of the regrown epitaxial layer.

20. The method of claim 16, wherein the regrown epitaxial layer is processed to form a device layer having a specific resistivity using dopants containing ambient during the regrowth process.

21. The method of claim 16, wherein the regrown epitaxial layer is processed to form a device layer having a specific resistivity by ion implantation.

22. The method of claim 16, wherein the regrown epitaxial layer is used in the creation of nMOS devices on different layers.

23. The method of claim 16, wherein the regrown epitaxial layer is used in the creation of pMOS devices on different layers.

24. The method of claim 16, wherein the regrown epitaxial layer is processed to form an interposer structure with a specific resistivity using dopants containing ambient during the regrowth process.

25. The method of claim 16, wherein the regrown epitaxial layer is processed to form an interposer structure with a specific resistance by ion implantation.

26. The method of claim 16, wherein the regrown epitaxial layer is used for specialized applications selected from the group consisting of creation of interposer for radio frequency components with graded resistivity, creation of a new packaging interface with optimized input and output density, provision of additional functionality, provision of memory device stacking, provision of mixed signal device stacking, formation of a custom made fixture, and combinations comprising at least one of the foregoing specialized applications.

27. The method of claim 12, wherein the processing step further comprises the step of fabricating a transferable decal layer on the carrier substrate.

28. The method of claim 27, wherein the decal layer comprises functional semiconductor components and interconnects.

29. The method of claim 27, wherein the porous region is thermally treated to form a regrown epitaxial layer, the regrown epitaxial layer being processed to form a device layer before the decal layer is created.

30. The method of claim 27, wherein the porous region is thermally treated to form a regrown epitaxial layer, the regrown epitaxial layer adding functionality to the decal layer.

31. A method of forming a three dimensional integrated structure, the method comprising the steps of:

bonding a decal structure comprising a transfer layer on a carrier substrate, the substrate having a porous region with a tuned porosity in combination with an implanted species defining a separation plane therein, to a receiver structure; and

separating the transfer layer from the substrate at the separation plane in the porous region.

32. The method of claim 31, wherein the receiver structure comprises a base-substrate and a component layer.

33. The method of claim 31, wherein the component layer comprises a semiconductor component.

34. The method of claim 31, wherein the component layer comprises a semiconductor component selected from the group consisting of semiconductor device elements, circuit elements, memory elements, thin-film layers, passive elements, active elements, interconnecting elements, micro-electro-mechanical elements, optical elements, optoelectronic elements, photonic elements and combinations comprising at least one of the foregoing components.

35. The method of claim 31, wherein the porous region is thermally treated to form a regrown epitaxial layer.

36. The method of claim 35, wherein the regrown epitaxial layer is processed to form a device layer after separation is performed.

37. The method of claim 35, wherein the regrown epitaxial layer is processed to form an interposer structure providing mechanical support and heat spreading functions.

38. The method of claim 31, wherein the steps of bonding and separating are repeated multiple times to create a multi-layer three-dimensional integrated structure.

39. The method of claim 31, wherein separation of the transfer layer from the substrate is initiated at the separation plane.

40. The method of claim 31, wherein separation of the transfer layer from the substrate comprises incorporation of a capping coating.

41. The method of claim 40, wherein the capping coating comprises a material selected from the group consisting of silicon oxide, silicon nitride, silicon carbide, amorphous films and combinations comprising at least one of the foregoing compounds.

42. The method of claim 40, wherein the capping coating comprises interconnects therein.

43. The method of claim 40, wherein the capping coating acts as a hardmask.

44. The method of claim 31, wherein a portion of the porous region remains on the transfer layer after separation.

45. The method of claim 44, wherein the portion of the porous region remaining on the transfer layer after separation is processed to form a heat sink by metalization.

46. The method of claim 31, wherein bonding the decal structure to the receiver structure comprises direct bonding of materials selected from the group consisting of oxides, nitrides, silicon and combinations comprising at least one of the foregoing materials.

47. The method of claim 31, wherein bonding the decal structure to the receiver structure comprises indirect bonding of an intermediate layer selected from the group consisting of metal-containing layers, polymer-containing layers, low-k material-based adhesive layers and combinations comprising at least one of the foregoing layers.

48. The method of claim 31, wherein the transfer layer is separated from the substrate using a splitting technique selected from the group consisting of ultrasonic waves, thermal stress induced by heating or cooling, oxidation from the edge, insertion of a solid wedge, insertion of a fluid wedge and combinations comprising at least one of the foregoing splitting techniques.